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THE BACKGROUND TO RICE VARIETY IMPROVEMENT IN MALAYA

L.N.H. Larter
Agricultural Chief Research Officer
Department of Agriculture, Federation of Malaya

INTRODUCTION

MALAYA has always been an importer of rice and in consequence of the hazards of dependence on foreign supplies the need for a substantial increase in home production has for a great many years been realised. In recent times these hazards and this need have substantially grown and there are now few of the possible methods of increasing production with which at least a start has not yet been made in Malaya. Increased acreage, improved water supply and drainage, pest and disease control, the use of fertilisers, better agronomic methods and production of higher yielding varieties are all being undertaken. It is with the last of these that this paper is mainly concerned. Malayan varieties are almost entirely lowland *indica* types; little dry padi is grown and it is only recently that introduced *japonica* varieties have been cultivated to any extent.

Editor's Note: In this and the next issues, a series of seven articles on rice improvement in Malaya will be published as background for those who will be attending the meetings of the two Working Parties of the International Rice Commission in Penang, Malaya, on 5–11 December this year.

EARLIER WORK IN VARIETY IMPROVEMENT

Consideration was first given to rice varietal improvement in Malaya in 1912 and though simple yield trials were commenced in 1913, it was not until 1916 that a systematic approach was made to improving varieties by selection. From then until 1941, pedigree pure line selection was carried out with some twenty or more varieties and a similar number of valuable high yielding pure lines were isolated, field tested and distributed to planters. Several of these selections, such as Siam 29, Nachin 11, Reyong 6, Seraup Kechil 48, Mayang Ebos 80, Radin China 4 and Radin Siak 34 are still among the best yielding and most widely grown varieties available today. This work undoubtedly contributed in a large degree to increased yield, but to precisely what degree cannot be determined for, at the same time, improvement in water supply and control and other agronomic factors was also in progress. Suffice it to say that the average yields of padi per acre were increased in Malaya by some fifty per cent, from 1,000 lbs. in 1925 to 1,700 lbs. by 1940.

THE EFFECT OF THE WAR

During the war years, most selection stocks and many of the improved varieties were lost. Fortunately, the best of the pure lines which had been widely distributed in the pre-war years were recovered and repurified. Selection work had, however, to recommence from the beginning. In the first post-war years, yields had fallen back to the 1929 level of some 1,200 lbs. per acre, largely owing to poor cultivation and inefficient control of rats and other pests. These defects were soon remedied and with redistribution of improved seed, yields were restored by 1949 to the pre-war level. Since then they have continued to increase and are now in the region of 1,850 lbs. per acre. Meanwhile, pure line selection work has continued and expanded to include most of the major varieties grown in the larger rice areas of the Federation. As only nine years has elapsed since the resumption of this selection work, no new high yielding varieties have yet been generally distributed. Final yield tests of new selections of two varieties are now in progress on farmers' land and general release of seed within the next two years is planned. Nachin 5057 is expected to increase yields by twenty per-cent over 17,000 acres of coastal Malacca, and Serendah Kuning 5011 and 5023 to increase yields by fifteen per cent over 30,000 acres of rice lands in Negri Sembilan.

THE SCOPE FOR IMPROVEMENT

Increased yield is the dominant aim in rice improvement in Malaya. The population of the country doubled in the forty years from 1910 to 1950 and with the present rate of increase may be expected to double itself again before the end of the century. By that time a fourfold increase of present production will be necessary to meet requirements. Though such an increase may by possible, were an uninterrupted campaign to increase production by all possible means sustained for the next two or three decades, it is doubtful if it will be achieved in practice.

After some centuries of empirical mass selection by the rice planters, there are now many highly developed and efficient varieties in cultivation in Malaya. Most, if not all of these, are, however, still susceptible of further improvement by scientific methods of selection. How much this improvement may contribute to increased yield is problematic. The maximum improvement in yield which has so far been obtained in small trials is around 35 per cent. Over areas of the order of 10,000 acres in which unselected varieties are now grown, increases of 20 per cent have been shown to be possible. Over the whole country it is reasonable to expect a yield increase of 15 per cent by the use of pure line selections from indigenous populations and with development of adapted hybrid selections this may well be increased to 25 per cent.

DEFINING THE PROBLEM

A satisfactory attack on the overriding problem of increased yield calls for an analysis of the factors which at present limit yield. They must be defined, weighed and if not eliminated at least minimised. This is of particular importance in a country such as Malaya where staff and facilities are adequate to cope with only a small proportion of these problems at any one time. Their relative importance should be carefully assessed so that the more potent factors may be tackled first. This calls for a comprehensive field survey of factors affecting rice production, for without this, improvement work must be of necessity to a large extent empirical and inefficient. Such a survey is needed, if only to assess those of the factors limiting yield which may be susceptible of control, such as water supply, pests and varietal deficiencies, and distinguish them from those that may not, such as soil and weather variations. In the absence of this basic information, it is assumed that increased production may be achieved in the following ways, listed in approximate order of importance: expanded acreage, more efficient water control, direct control of pests and diseases, the use of fertilisers and other methods of improved agronomy, and higher yielding varieties. This last item is again divisible into component problems in various ways.

The polygenic complex which primarily determines the yielding capacity of any variety provides the basis for improving yield by selecting for an optinum combination of these genes. This complex has not yet been effectively analysed. Though yield is obviously related to tillering, ear size, grain weight and similar characters, correlations between yield and these characters are in some cases positive and in others negative. Selection for yield is therefore still empirical to the extent that it must be based on direct yield measurement. Accessory yield determinants with which selection in Malaya is concerned in greater or lesser degree are resistance to lodging, flood, drought, pest and disease, and response to fertiliser. Until their relative importance in limiting yield can be assessed, this order is taken as being that of descending importance.

In addition to high yield, selection in Malaya also aims at reducing maturation period, maintaining or improving grain

density, milling and cooking quality and palatability.

CURRENT WORK — TRIALS OF INDIGENOUS VARIETIES

In the first place we are endeavouring to improve yield by the more efficient utilisation of indigenous unselected varieties. This involves determining, by replicated variety trials, which of the local varieties of each area will give the best yield. These varieties are then tested throughout the area concerned and where they prove satisfactory their cultivation is encouraged and seed distributed. They are also listed in other areas in comparison with the best local varieties of these other areas. Some 150 such trials have been undertaken since 1947 at the 45 or so Padi Test Stations in the country, and results of over 100 of them have been published. (1, 2). These have dealt with the majority of the more important Malayan varieties, and further trials of this type are now only being laid down to deal with special local problems such as those arising in areas being newly developed for rice cultivation.

SELECTION

Varieties which have proved to be high yielding in these trials are then subject to pure line selection by the ear row method. Such selection work with fourteen varieties has been commenced since 1946 and is now well advanced in the case of seven of them. As mentioned earlier, two of these projects have reached the stage of final regional trials and preliminary seed distribution. There still remain some ten or fifteen major varieties in which no selection work has yet been carried out but which may be expected to respond profitably to selection.

TECHNIQUE

The techniques used in Malaya in comparative variety trials and in pure line selection are essentially the same as those used by workers elsewhere. Selection technique is still in process of improvement and is modified in detail from time to time as experience indicates. Recent experience has for instance shown that a considerable amount of the variation in relative varietal behaviour is due to seasonal effects and that records of such quantitative characters as yield are required over at least three and often more years before seasonal effects can be assessed and allowed for. Without such data the danger of inadvertently discarding valuable material is considerable.

OTHER ECOLOGICAL CONSIDERATIONS

Decentralisation is desirable at the earliest possible stage in selection as it has been found that many, though not all, pure lines are hypersensitive to small differences in environment, and that ideally all stages of selection should therefore be carried out in the area in which the selected varieties will eventually be used. For the purposes of varietal improvement the padi lands of Malaya have been divided into twelve or more main ecological areas. They differ in such factors as latitude, type and fertility of soil, rainfall quantity and distribution, availability of irrigation, etc. As data are accumulated it is hoped in due course to be

able to define them on a physical basis using these factors. So far they have been defined largely in terms of differences in their indigenous padi varietal floras which, owing to the limited ecological adaptability of most varieties, is often striking. These ecological areas all differ in one or more major ecological factors and each therefore presents a different set of problems relating to factors limiting yield. Though broadly speaking there is therefore need to undertake 12 or more separate varietal impovement programmes for the various ecological areas, the situation is further complicated by the environmental variation within each area and the consequent existence of many ecological sub-areas. For the time being it is hoped to cater for this minor variation by selection of adaptable general purpose varieties which will give an appreciably increased yield over a wider area though they may not be capable of giving the maximum yield over the more limited and uniform sub-areas of ecological units.

MAJOR AND MINOR VARIETIES

For reasons too numerous to detail here, in each area in Malaya there are generally only two or three dominant unselected varieties which provide the bulk of the rice production, though there may be several hundreds of varieties grown. Each of these dominants, though easily distinguishable by its major morphological characters, contains a wide range of genetic variation. These dominants have become such as a result of their selection by the planters and in most cases because they are higher yielding of the varieties of the district. For this reason the practice in Malaya is to undertake selection for each area variety by variety, rather than, as is often done elsewhere, attempt to deal with all varieties in each area at one time. This practice involves the assumption that the best strains obtainable in practice from all varieties, which may or may not be so. The alternative procedure would however necessitate handling a far greater volume of material in the early stages of selection than existing facilities can deal with; tens if not hundreds of thousands of strains would need to be studied.

HYBRIDISATION AND THE FUTURE.

While pure line selection in indigenous varieties is steadily increasing yield and improving other factors, it is apparent, from reasons discussed more fully elsewhere in this issue, that future varietal work in Malaya will depend more and more upon hybridisation. This will be so particularly in relation to new problems arising out of changing agricultural systems. The increasing use of fertilisers calls for the selection of highly responsive varieties. The wider use of the more high yielding varieties, which are often intolerant of fluctuating conditions, will be admitted by improvements in irrigation services. Mechanised cultivation, though still in its early stages in Malaya, will require the development of varieties with special characteristics. The rapid expansion of the double cropping system which is now taking place has exposed a deficiency of high yielding short-term non-photosensitive varieties. The opening up

of new rice areas and development of new soils, such as peat and the highly reduced sulphurous *gelam* soils, call for varieties we do not yet possess. These and numerous other special problems related to particular areas or conditions, which will be dealt with as staff, land and facilities become available, must depend for their solution on selection in hybrid populations.

REFERENCES:

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RICE HYBRIDIZATION IN MALAYA

F.B. Brown
Agricultural Senior Botanist
Department of Agriculture, Federation of Malaya

Rice hybridization is a comparatively new aspect of the rice improvement programme in the Federation of Malaya. Previously in the periods 1919 to 1920 and 1927 to 1932 preliminary observations were made on the floral biology of the rice plant with a view to the development of a suitable technique for obtaining and handling hybrids. No planned programme was formulated because staff and land requirements were not sufficient to carry on a hybridization programme as well as pure line selection work which was then proceeding and which promised more immediate practical results, In addition there was little or no detailed information available to enable promising parents to be selected.

After the last war (1942 to 1945) pure line selection work in indigenous varieties had practically to start afresh and it was recognised that while it would steadily increase yield it was improbable that the optimum combination of those genes which determine yield was to be found ready-made and that some re-combination by hybridization would be profitable. Also, the changing agronomic practices would require the incorporation of genes which do not form part of the makeup of indigenous Malayan varieties and therefore we must look to hybridization with introduced varieties to provide them.

Since 1946 preliminary work for a future hybridization programme was carried out by centralising collections of local varieties so that suitable parental types might be segregated. These variety collections are now distributed as follows:

Long Term Varieties (West Coast)
– Titi Serong, Perak.

Long Term Varieties (East Coast)
– Jelawat, Kelantan.

Medium Term Varieties (West Coast)
– Pulau Gadong, Malacca.

Medium Term Varieties (East Coast)
– Kota Bharu, Kelantan.
Medium Term Varieties (N.W. Malaya)
– Telok Chengai, Kedah.

Short Term Varieties (less than 160 days) are incorporated in the medium term collections but will shortly form separate collections at Bukit Merah (Province Wellesley) and Talang (Perak). Some 1,100 different named varieties are included in these collections.

From time to time varieties have been introduced from foreign countries but on the whole these introductions have not been successful. The most common drawback is their precocity; maturation periods of 60 to 70 days with extremely poor tiller production are the order rather than the exception. However, when an introduced variety has shown any likelihood at all of being of use, it has been incorporated into the Pulau Gadong collection.

It is planned to undertake breeding work at all stations where variety collections were maintained but so far only Pulau Gadong and Telok Chengai have been used.

In 1950 preliminary crosses were made between local varieties partly to evolve a a breeding technique suitable for local use and partly to assess the variation in progenies from closely and distantly related local varieties and to explore the possibilities of combining genes for high yield, strong straw, prolific tillering, shorter maturation period and rice quality. These characters occurred separately or in various combinations in the parental types used. At first, these hybrids were grown at Pulau Gadong only, but were later duplicated at Telok Chengai in Kedah for parallel selection in the northern part of the Federation.

Fifty three crosses are being handled in both progeny plots and as pedigree lines, the F_5 generation is being planted in the 1955-6 season. Although segregation is still active the results so far are quite promising. The only combination which is not apparent is the introduction of the shorter maturation period. Progenies resemble the later maturing parent in this respect in almost all crosses. As all parents were of the photosensitive *indica* group there is no possibility of a 'period fixed' strain being produced in these progenies.

In addition to these 'local' hybrids, Malaya is also an active participant in the *indica* x *japonica* rice hybridization scheme of the International Rice Commission. These hybrids have been grown at Pulau Gadong since 1952 and also at Telok Chengai from 1953. The present stocks include material at all stages from F_2 to F_5 in both pedigree lines and bulked progeny plots. In addition F_5 progeny plots are being grown in the off-season at Bukit Merah, Province Wellesley, to assess the value of 'period-fixed' strains occuring in these families.

It is too early to forecast whether direct use may be made of the *indica* x *japonica* hybrids but in any case a good supply of valuable genes is now available for use in future breeding work.

HANDLING OF HYBRID MATERIAL

1. Emasculation Technique

Varying degrees of success were obtained with different methods of emasculation. Among those tested were:

(a) By cutting the lemma and palea below the anthers inside, no seed set was obtained in any florets so treated probably due to excess injury.

(b) By removal of the anthers with fine pointed forceps after the tips only of lemma and palea were cut off. This method proved satisfactory provided that anthers were removed in the evening prior to pollination on the next day. If the operation was left until the same morning as pollination, the percentage of selfs was considerably increased. This method however is tiring especially if carried out in the field but all crosses represented in the 'local' hybrids were made in this fashion.

(c) The suction method whereby a fine glass tube is inserted between the tips of lemma and palea over the anthers and through which the anthers are sucked out. This was moderately successful but, probably through lack of experience, the percentage of anthers bursting in the process was high.

(d) The hot flask treatment. This method was thoroughly tested in 1952 and was very successful. The panical is introduced into a thermos flask, heated previously by hot water to 44°C., and remains inside for 10–12 minutes. When withdrawn the florets have opened and the filaments have become fully extended and the anthers can be cut off. Provided that the treatment was done in the morning of pollination before 8.30 a.m. no bursting of anthers occurred. The advantage of this method is that there is no damage to the floret and a normal shaped seed is produced.

Transference of pollen to the emasculated floret presented no difficulty in the original crosses which were done in the field between varieties of similar maturation period but rigid synchronisation of flowering will be necessary where maturation periods differ as no method of storing pollen is available.

After pollination the panicle is labelled and enclosed for 3 to 5 days by a brown paper bag after which time the bag is removed.

2. Storage of hybrid seed

Under Malayan conditions it has been found that F_0 and F_1 seed especially, is liable to lose its viability very rapidly. Losses in F_2 seed of the *indica* x *japonica* crosses were also incurred. Crosses involving short term non–photosensitive varieties must be kept for 8 or 9 months from harvest until sowing and under normal storage conditions loss of viability during this period is high. Reten-

tion of viability is assured if seed is kept in an air–conditioned atmosphere at 75°F or to a less extent in desiccators at normal temperatures.

3. Germination of F_0 seed

In order to avoid loss of F_0 material by faulty germination techniques various methods have been tested. The germination of mis–shapen seeds from cut florets is especially poor unless precautions are taken.

The various methods tested included use of dehusked and unhusked seeds treated with 0.1 per cent mercuric chloride solution, formalin and various commercial seed dressings in both sterile and asterile conditions. By far the most successful was the mercuric chloride treatment of dehusked grain but there was little difference whether the germination was effected in sterile or asterile conditions.

4. Handling in the field

All hybrid material is handled by both the pedigree and bulked progeny method. Pedigree lines of 50 plants are grown from plants selected from progeny plots of each generation. From the heterogeneous pedigree lines of the earlier generations, the best two or three plants are selected for the next season's crop.

F_1 Progeny plots are planted from all available seed but due to limited space available, subsequent generations are restricted to 1/10 acre or in some cases 1/20 acre plots. The seed used for planting progeny plots is a random sample of bulked seed from the previous season's pedigree lines and progeny plots (obviously undesirable types having been discarded in the field).

Yield records of pedigree lines are taken in full and visual assessments recorded of tillering capacity, straw strength, height and other desirable characters. Yield records of progeny plots are also measured in order to provide relative figures for family comparisons. For ease of harvesting and to minimise accidental mixture of seed of different families, pedigree rows and progeny plots of the same cross are planted adjacent to each other.

NOTE ON THE BEHAVIOUR OF LOCAL MALAYAN HYBRIDS

1. Hybrid Vigour

In 1952, the expression of hybrid vigour was studied in the F_1 generation of 28 of the local crosses and the following general conclusions reached.

(a) There was a significant increase in tiller production over the parental means, the increase varying from 3.2 per cent to 88.51 per cent representing a mean increase of 5 tillers per plant.

(b) Yield increases likewise showed an increase of 9.1 to 130.5 per cent.

(c) Heterosis was not expressed as a shortening or lengthening of total maturation period (sowing to harvest) but may be exhibited by an increase in grain weight.

2. Lodging Resistance

Variation in resistance to lodging appears to be sufficient in some families,

even in hybrids between susceptible parents, to offer opportunity for isolating resistant strains. In the F_3 generation of the local hybrid family 5001 Siam 29 x Radin Siak 34 (both parents lodge), almost 100 per cent of the plants were lodged, but a few of the plants least affected were retained. In the F_4 generation a marked increase in lodging resistance appeared.

In another family, Siam 29 x Banyak Anak, the strong straw character of the male parent was almost completely dominant in the F_4 generation without loss of the desirable grain characters or yielding capacity of the Siam 29.

3. Penyakit Merah Resistance

The physiological disease known as *Penyakit merah* causes annual losses of varying amounts in Malaya. During the 1954/1955 rice season at Pulau Gadong, Malacca, it was particularly prevalent and there appeared to be appreciable variation in susceptibility both between and within families of the local hybrids. In the progeny rows of the cross Siam 29 x Banyak Anak very obvious cases of resistance were apparent.

The local hybrids, on the whole, are showing very promising results; yields in some cases are better than those from established superior strains and there are indications that direct benefit will be obtained from them in due course.

COMPARISONS BETWEEN LOCAL AND INDICA X JAPONICA HYBRIDS

As both sets of hybrids have been grown together in the field at the same time there are a number of interesting comparisons which can be made.

In the earlier generations, extreme segregation of most characters is very apparent in the *indica* x *japonica* hybrids as also is the successive tiller emergence and flowering habit. Awned segregants are commonly found in both sets of hybrids, in families both of whose parents are unawned.

Seedling of the F_2 and F_3 generations of local hybrids are able to tolerate the accustomed depth of water which often occurs in Malaya just after transplanting normal varieties, but rigid water control is necessary in the corresponding *indica* x *japonica* generations otherwise heavy losses occur at this period.

Sterility in the earlier generations of local hybrids is almost absent but is very noticeable in the other group. Microsporocytes form 20 *indica* x *japonica* families were examined meiotically at stages from metaphase I to anaphase II. In all, chromosome number and behaviour at both divisions was essentially normal as also were pollen tetrads and variability in pollen size. Only a few cells exhibited bivalents with delayed separation and 'lagging' chromosomes, An anaphase bridge was found only in one cell. Chromosome irregularity is therefore inadequate to account for the sterility found in this material and it must be assumed that the cause is primarily genic.

One feature of the *indica* x *japonica* group which is most striking and not exhibited by the local hybrids is their

differential behaviour at Pulau Gadong in Malacca and Telok Chengai in Kedah. At the former rice station, growth has been poor and yields low, at Telok Chengai vegetative growth and yields have been almost comparable with medium quality local *indica* types. It is also noteworthy that crosses with Taichu 65 and Pebifun (Pehbihun) as the *japonica* parents are more vigorous and higher yielding than those with other *japonica* parents. Taichu 65 and Pebifun are already established varieties in this country.

As the Fedeattion of Malaya produces only some 50 per cent of its total rice requirements for home consumption, yield is the most important consideration in present hybridization programmes. Future breeding work will involve crosses between high yielding strains at present being obtained by pure line selection of local varieties, and the production of new varieties for specialised regions and agronomic practices.

SOIL SURVEY OF JUNGLE SWAMPS FOR PADI CULTIVATION[1]

J.K. Coulter

Agricultural Senior Soils Chemist

Department of Agriculture, Federation of Malaya

INTRODUCTION

In Malaya there are very large areas of undeveloped swampy land, particularly on the west coast. These areas are covered with thick impenetrable virgin jungle, which is made even more difficult to traverse by the swampy nature of the terrain. It is in these that the future expansion of Malaya's rice areas is destined to take place.

In the following paragraphs a brief description is given of the methods of survey of one such typical area of approximately 200,000 acres, known as the Trans–Perak Swamp.

METHODS OF SURVEY

Before opening up these areas for a padi scheme there are several factors which need to be examined. The first is the usual measurement of water flow (in this case the Perak River) from a point of view of irrigation. Such studies are carried out by the Drainage and Irrigation Department and entail measurements of water flow over a considerable period of time. Next, levels have to be taken over the area, and in this the Drainage anh Irrigation Department and the Department of Agriculture co–operate. To enter the area, paths are cut through the jungle on compass bearings. The distanee apart of the paths vary from scheme to scheme, but may be from half a mile up to one mile, depending on the size of the scheme and the nature of the terrain. Along these lines, levels are taken at fairly frequent intervals Where ridges or irregular land is

1 *The results of this survey will be described in detail in a paper to be published in the Malayan Agricultural Journal.*

encountered, more detailed levels are taken. Along these lines soil samples are also taken at stated intervals, usually one quarter mile; at the same time the depth of peat, if present, is measured. This peat depth measurement is improtant, because it has been Malayan experience that only very poor crops of padi can be grown on peat, even with manuring. The taking of samples at regular intervals involves a lot of work but it is the only practical method in these swamp surveys' since trained soil survey staff is not available for identification of soils in the field, and thus laboratory classification of peats, clays, loams, etc. is necessary.

In the Trans—Perak Survey, about 3,300 samples were taken. Samples at each sampling point were taken at 0 to 9 ins., 9 to 19 ins. and, where the peat was less than 5 ft. deep, a sample beneath the peat was obtained.

The survey of this large swamp area differs from the usual soil survey in that the soil map has been constructed largely on the basis of laboratory data. These include loss on ignition, mechanical analyses, pH, "readily soluble" phosphorus and potassium, conductivity and water soluble chlorides and sulphates.

Aerial photographs, on a scale of 1:25,000, were available for the whole area. It was hoped that these could be used to distinguish differences in the jungle which could then be correlated with the soil boundaries. It was thought that there might be marked visible differences in the jungle growing on deep peat and that growing on clay or shallow peat. Although some differences in the density of the jungle were obvious, these could not be correlated with the soil map. In a flight over the region at 1,500 to 2,000 ft. an area of very poor jungle was noted and this corresponded to an area of poor sandy soils and peat over sand. The vegetation consisted of isolated large trees in a mass of small palms and ferns.

DESCRIPTION OF THE SOILS

Peats and mucks. Peat is defined under the usual convention as material with a loss on ignition of more than 65 per cent and muck as material with a loss on ignition between 35 and 65 per cent. In mapping, the peats and mucks were not differentiated. From the depths recorded during the survey a peat depth contour map was constructed showing the areas of peat with depths of 0 to 2 ft., 2 to 5 ft., 5 to 10 ft. and greater than 10 ft. Out of a total area of 200,000 acres the distribution of peat was as follows:

Peat and mucks over 10 ft. deep	–	24,000 acres
,, ,, ,, between 5 and 10 ft. deep	–	23,000 ,,
,, ,, ,, ,, 2 and 5 ft. deep	–	16,000 ,,
,, ,, ,, less than 2 ft. deep	–	8,000 ,,
Total:		71,000 acres

As it is the general case with peats in Malaya the ones from Trans-Perak are quite acid, 86 per cent of the samples having a pH value between 3.7 and 4.9.

"Readily soluble" phosphorus, as determined by extraction with ammonium fluoride – hydrochloric acid solution, is of the same order as that found for clays, only 10 per cent of samples having values above 40 p.p., P. It is the "readily soluble" potassium values, as determined by extraction with N/2 acetic acid, which are so surprisingly high – 68 per cent of the samples having values greater than 200 p.p.m., K – far higher than those obtained for clay soils. The reason for these high values is not known because peat soils generally respond to potash dressings, although trials with potash on padi has only given very limited response in Malaya.

Mineral Soils. Under this heading, all soils which are not peats and mucks are included. Since all the mineral soils in the area are recent alluvium they have no properly developed profile, and a textural classification based on the results of mechanical analyses has been adopted. It is realised that this type of classicfication can be severely criticised on the grounds that arbitrary lines have been drawn on a classification based solely on laboratory examination. While this is accepted, reference to the literature has not revealed any better methods which could be applied to such large waterlogged areas.

The soils have been classified on the basis of the terms used by the United States Soil Survey. The greater proportion are clays and clay loams. In the past great attention has been paid to the texture of soils, particularly when deciding their suitability for padi cultivation, Those with a high clay content were regarded as the best padi soils because they held water better, but where the whole area is flooded and the water table raised to form a swamp, the texture of the soil as a contributory factor towards holding of water becomes of less importance. Heavy textured soils more probably owe their reputation for being good padi soils to the fact that they are generally richer in plant nutrients, particularly if laid down under marine conditions. Nevertheless, soil texture is one of the most important properties of a soil as it is one that cannot readily be altered.

The analyses of the mineral soils show them to have a slightly higher average pH values than the peats. Phosphorus values are approximately the same as those for peats, but the potassium values are very much lower, 50 per cent of the samples having values below 80 p.p.m., K. In addition to the above measurements, the conductivity of all samples was measured and in those with a value above 200, (mhos x 10^{-6}) water soluble chlorides and sulphates were determined. The determination of sulphates is particularly important, as it has been found that some Malayan soils are high in this toxic material. Very few of the Trans-Perak soils contained sulphate in quantity though many of them contained traces of chlorides.

DEVELOPMENT POTENTIALITIES OF THE AREA

The most serious obstacle to development is the large block of deep peat occurring right in the centre of the area and, as stated earlier, our experiences to date indicate that padi growing on peat is uneconomic and that inclusion of an area of deep

peat or muck within a padi scheme would be undersirable. The obvious way round the difficulty would be to let the peat remain under jungle or develop it for crops which are known to grow well on it, e.g. pineapples on deep peat and coffee on shallow peat. However in the case of the Trans–Perak area, drainage will present difficulty. Another problem presented by the area is the fact that strips of peat occur amongst the clay.

As regards the mineral soils, we do not have nearly enough information on the alluvial soils of Malaya to make a full evaluation of their potentialities on the basis of laboratory analyses. Comparison of these soils with those found in other areas where the yields of padi are known, indicates that they will make fairly good but not top-yielding soils.

It is probable that, on account of the patchy nature of the peat, development of the area will have to be of a more piecemeal nature than was originally planned.

As surveys of Malaya's larger coastal swamps progress, primarily with a view to their development for padi, evidence is accumulating that peat occurs, unfortunately in considerable extent and depth within a few miles of the coast in nearly every area.

Present indications are that it may never be economic or even possible to grow good crops of padi on peat and we may be forced to accept the fact that the widespread occurrence of deep peat will severely reduce the area of potential padi land under jungle. A solution of the problem of economic utilization of deep peat may have very wide application.

SUMMARY

A brief outline is given of the methods of soil survey adopted in a large area of virgin swamp jungle which was being investigated for padi cultivation.

The method of soil classification is given together with a brief discussion on the large areas of peat which occur in the swamp.

The improtance of a method of utilization of the deep peat in the potential padi areas is indicated.

DISEASES OF RICE IN MALAYA

Anthony Johnston

Acting Senior Plant Pathologist

Department of Agriculture, Federation of Malaya

The object of this paper is to give brief notes on the commoner diseases of rice as they occur in Malaya. Descriptions of the causal organisms are not given, nor are symptoms described in detail, as the parasitic diseases mentioned are all of widespread occurrence and have been fully described elsewhere.[1]

1 *e.g. Manual of Rice Diseases by B. Watts Padwick, Commonwealth Mycological Institute, 1950.*

A list of all fungi so far recorded on rice in Malaya is included.

The commonest diseases are

Brown spot (*Ophiobolus miyabeanus Ito & Kuribay = Helminthosporium oryzae* Breda de Haan)

Blast (*Piricularia oryzae* Cav.)

Narrow brown leaf spot (*Cercospora oryzae* Miyake)

Sheath blight (*Corticium solani* (Prill. & Delacr.) Bourd. & Galz.)

Stem rot ((*Leptosphaeria salvinii* Catt. = *Helminthosporium sigmoideum* Cav. = *Sclerotium oryzae* Catt.)

False smut (*Ustilaginoidea virens* (Cooke) Tak.)

"Penyakit merah" (Physiological)

Brown spot (*Helminthosporium oryzae*) is most commonly seen in the seed-bed where it frequently causes very severe leaf-spotting, leading to dying off of the leaves from the tip and stunting of the seedlings. Heavily attacked nurseries can be recognised from a distance by their light-brown scorched appearance compared with the normal green of healthy plants. After transplanting the disease usually virtually disappears although a few leaf spots may be found throughout the growing season. As the plants reach maturity the leaf spotting may become more noticeable. Grains are commonly infected but such attack usually causes no more than slight spotting; seedlings grown from infected seed may, however, be killed off by the fungus soon after germination.

This is the most widespread of the padi diseases and can be found in practically every padi field. Experiments on the effect of seed treatment are in progress.

Blast (*Piricularia oryzae*). Like brown spot, blast is most often seen in the seed-bed. The commonest symptom is the production of large spindle-shaped leaf spots but in severe attacks the seedlings may be completely killed off. This is liable to occur particularly in dry nurseries. As in the case of brown spot, blast becomes of minor importance after transplanting although slight leaf-spotting can often be found on the more susceptible varieties throughout the growing period. Very occasionally the broken neck phase of the disease causes appreciable loss over small areas but this type of attack is rarely serious. Tests so far suggest that *Piricularia* is not commonly seed-borne.

Blast is not of such common occurrence as brown spot but can be found in most areas, although often only in trace amounts.

Control can be achieved in the nursery by spraying with a copper fungicide but the most satisfactory methods of control are the planting of wet nurseries and the use of resistant varieties. Apart from a few particularly susceptible varieties such as Nachin, Siam and Serendah Kuning most of the local varieties show considerable resistance to this disease,

Narrow brown leaf spot (*Cercospora oryzae*). The small linear lesions caused by *C. oryzae* generally only appear on plants in the later stages of growth and usally on the older leaves, where little damage is done.

Occasionally, however, particularly on a susceptible variety such as Serendah Kuning, heavy attacks occur at an earlier stage of growth, when damage is considerable.

This disease is common in all parts of Malaya and is very frequently found on maturing plants.

Sheath blight (*Corticium solani*). This disease is similar to oriental sheath and leaf-spot caused by *C. sasakii* in Japan, India, Ceylon etc. and the Malayan fungus may in fact be *C. sasakii*. Other fungi associated in Malaya with similar diseases are *Rhizoctonia microsclerotia* Matz. and R. solani[1] Khun. A strain Park and Bertus.

Most commonly *C. solani* attacks the outer leaf sheaths of plants which have passed the tillering stage. Infection begins as large, green, water-soaked spots, becoming light brown as they dry out. As the diseased area spreads the whole leaf sheath is killed and the leaf blade dries up and withers. In severe cases the fungus penetrates the inner leaf sheaths and the whole tiller may be killed. Under favourable conditions the fungal hyphae can spread up the surface of the leaf and attack the leaf blade, where large spots similar to those on the sheath are formed.

The disease is sporadic in occurrence and usually appears only in small patches although in a few localities (e.g. in North Johore) it has caused more widespread damage. Being dependent on high humidity the disease is usually found in lowlying areas, particularly where the water tends to be stagment. In such areas the disease recurs year after year and is difficult to eradicate.

C. solani also attacks seedlings and in humid conditions, when the seedlings are making lush growth, circular patches in the nursery may be killed off.

Stem rot (*Sclerotium oryzae*). This fungus first attacks the outer leaf sheaths, forming black, rotten areas. The sheaths later become dried up and the whole leaf dies. The fungus penetrates inwards to the stem which is also attacked and killed. Affected plants are stunted, with many tillers completely dead and most of the outer leaves of the remaining tillers dead or dying. Few ears are produced and they bear only a little light grain. Typical of this disease is the development at a very late stage of a small number of young tillers at the base of an affected plant.

The small black sclerotia of the causal fungus are formed between the leaf sheaths or inside the tissues of leaf sheath or stem.

As in the case of sheath blight, stem rot occurs in small scattersd patches and, although the damage done is often severe, the total area affected is small.

Fales smut (*Ustilaginoidea virens*). The conspicuous olivegreen fructifications of this fungus are frequently observed on ripening grains but the fungus is not prevalent enough to be of any economic importance. The appeance of the disease

1 *Editor's Note:* *Corticium solani* and *Rhizoctonia solani* seem to be different names of the same fungus.

is sporadic and only a few grains on scattered heads are affected.

Penyakit merah. The conspicuous features of this disease are reflected in the vernacular names applied to it — "penyakit merah" (red disease), "Penyakit rendah" (stunting disease), "penyakit kisar" (reversal of growth disease) and "benah darah" (blood-coloured blight). Symptoms, which appear from two or three weeks after transplanting onwards, vary but in all cases there is a retardation of growth. All leaves except a few of the youngest show various discolorations of red, orange or yellow and dry up from the tips, dying prematurely.

Severely affected plants die before reaching maturity. If the attacks are less intense the plants may remain alive but are stunted and produce no grain. Slight attack results in a temporary cessation of growth; the plants later recover and produce a reduced amount of grain.

Penyakit merah has been observed in most parts of the country. Usually it occurs in small scattered patches, tending to recur in the same place in successive years but in some cases very large areas have been affected. The extent and severity of the disease vary greatly from year to year.

The cause of the disease is not known but does not appear to be a parasitic organism. A nutrient deficiency has been suspected but experimental work has so for not given conclusive results. Further investigations are in progress.

LIST OF FUNGI RECORDED ON RICE IN MALAYA

Actinomyces sp.	On straw
Cercospora oryzae Miyake	Narrow brown leaf spot
Corticium solani (Prill. & Delacr.) Bourd. & Galz.	Sheath blight
Curvularia geniculata (Tracy & Earle) Boedijn	On necks
Curvularia lunata (Wakker) Boedijn	On straw
Dinemasporium oryzae Miyake (?)	On straw
Entyloma oryzae H. & P. Syd.	Leaf smut
Leptosphaeria salvinii Catt	Stem rot
Marasmius stenophyllus Mont.	Leaf sheath decay
Mucor varians Povah	Mould on necks
Myrothecium striatisporum Preston	Leaf disease
Neovossia horrida (Tak.) Padwick & Azmat. Khan	Blak smut
Nigrospora oryzae (Berk. & Br.) Petch	On leaves
Nigrospora sphaerica (Sacc.) Mason	On leaves

Ophiobolus miyabeanus Ito & Kuribay	Brown spot
Piricularia oryzae Cav.	Blast
Pleosphaerulina oryzae Miyake	On straw
Pyrenochaeta oryzae Shirai	Spot on glumes
Rhizoctonia microsclerotia Matz.	Sheath rot
Rhizoctonia solani Kuhn A strain Park & Bertus	Sheath blight
Sclerotium rolfsii Sacc.	Stem rot
Sporodesmium bakeri Syd.	On dying seedlings
Stachybotrys sp.	On necks
Trichoconis padwickii Ganguly	Mould on necks, spot on glumes
Ustilaginoidea virens (Cooke) Tak.	False smut

REVIEW OF "FACTORS AFFECTING RICE PRODUCTION",

FAO Agricultural Development Paper No. 45

At one of the very early meetings of the International Rice Commission while discussing problems of rice production, the delegate from India posed the question — Why do acre yields in the different rice growing countries vary so enormously? It was not possible to give a simple answer to the question. The Commission however decided to circulate a specially prepared questionnaire and invite answers from all rice growing countries. Replies received have been analysed and the above paper deals briefly with that analysis. The data furnished by the countries have also been summarised in a table attached to the paper.

The information has been analysed under five headings: 1. climate and geographical conditions, 2. soil conditions, 3. water supply, 4. farming practices and 5. economic conditions.

One thing that is very definite is that yields are on the whole considerably higher in warm temperate regions than in the tropics. It cannot however be said that the climatic conditions associated with warm temperate regions, namely, short season, mild temperature and long day, are alone responsible for the high yields. In the tropics where rice is grown mostly as a monsoon crop with cloudy weather and not much of [sunlight, yields are comparatively lower than when the same crop is grown in cloudless sunny weather in summer. It is found that in addition to climatic differences,

other favourable conditions such as better water supply, intensive manuring, crop rotations, etc., also obtain in the warms temperate regions. Seasonal conditions might have an influence on the response of varieties to the use of manures and fertilizers.

While rice is grown in practically all kinds of soils, it would appear that rice performs best in heavy soils with silt and clay fractions amounting to 50–60 %. It might be that the extension of rice cultivation to unsuitable soils may be one of the reasons for the low acre yields in the tropics. While the pH of the rice soils varies from 4.5 to 8.7, better yields are obtained in neutral or acid soils than in alkaline soils.

Adequate and timely supply of water is perhaps the largest factor affecting yields. In most tropical countries, such water control is either absent or inadequate. Yields are, as a rule, better in irrigated than in purely rainfed areas, the actual amount of rain having no relationship with yields. Cultural practices which contribute to a better control of weeds favour higher yields and transplaning the crop in well prepared mud arrest growth of weeds. Straight sowing often in not well prepared land encourages weed growth and this is one of the causes for low yield in many areas of the tropics.

In the majority of tropical countries there is no systematical practice of manuring rice fields. Only in very recent years has the use of fertilizers for rice come into practice. Even the limited experimental evidence on manurial treatment available in some tropical countries has not been utilised and extended into cultivator's practice. The greatest scope for increasing yields in tropical countries appeared to lie in the increased judicious manuring of the crop. While many countries have, by breeding, produced improved varieties of rice, sufficient attention has not been given to their multiplication and distribution. Japan is the only country where 70 % of the rice area is occupied by improved varieties. It would appear that manuring the field and growing of improved varieties are interdependent and have to be taken together to produce the most satisfactory results, and this is clearly demonstrated in the warm temperate regions.

Rice varieties grown in different countries vary greatly in the maturity period but there is no apparent connection between the life period and yields. Highest yields are recorded with varieties of medium duration, say, a 5 months growing period. It is also apparent that varieties recording high yields have coarse or bold grain.

The economic problems like size of holdings, form of tenure and credit facilities are dealt with briefly, and it is evident that in many attempts to increase production, the matter of credit to the rice farmers must be given sufficient consideration.

The paper brings to light the manifold problems connected with modern rice cultivation and emphasizes how wide is the field that remains to be covered.

THE 1955 MEETINGS OF TWO WORKING PARTIES ON FERTILIZERS AND RICE BREEDING OF THE INTERNATIONAL RICE COMMISSION TO BE HELD IN PENANG, MALAYA

5-11 December 1955

At the kind invitation of the United Kingdom, the Sixth Meeting of the Working Party on Rice Breeding and the Fifth Meeting of the Working Party on Fertilizers of the International Rice Commission will be held simultaneously from 5–11 December, 1955, inclusive, at St. George's Girls' School, McAlister Road, Penang, Malaya. The Director–General of the Food and Agriculture Organization of the United Nations has issued invitations to all twenty-six member governments of the Commission to send highly—qualified scientists to attend these meetings.

The Provisional Agenda of these two Working Parties Meetings are given below:

Provisional Agenda

(For the Sixth Meeting of the Working Party on Rice Breeding)

1. Opening of the Meeting (jointly with the Working Party on Fertilizers).
2. Election of Chairman.
3. Adoption of Agenda.
4. Election of Draft Committee.
5. Reports from Countries on Progress in Rice Breeding in 1954.
6. The International Rice Hybridization Project:
   (a) Progress report from Cuttack.
   (b) Progress reports from Countries.
7. Maintenance of Genetic Stocks of Rice
8. The Second International Training Center on Rice Breeding.
9. Resistance to Lodging.

* 10. Progress Report on the ad hoc Working Party on Soil–Water–Plant Relationships.

* 11. Physiological Diseases of Rice.

* 12. Interaction between Varieties and Fertilizer Response.

13. Biological Control of Rice Pests.
14. Breeding for Blast Resistance.
15. Estimation of Losses due to Pests and Diseases of Rice.
16. The Inheritance of Yield Components.
17. Linkage Groups in Rice.
18. Proposals for Regional Cooperative Variety Trials.
19. Other Business.
20. Time and Place of Next Meeting.
21. Consideration of Draft Report.

**—Jointly with the Working Party on Fertilizers.*

Provisional Agenda

(For the Fifth Meeting of the Working Party on Fertilizers)

1. Opening of the Meeting (jointly with the Working Party on Rice Breeding).
2. Election of Chairman.
3. Adoption of Agenda.
4. Election of the Drafting Committee.
5. Report on the Second International Training Center on Soil Fertility in Relation to Rice Growing, Himayatsagar Agricultural Experiment Station, Hyderabad, India . . . 18 July – 15 October 1955.
6. The Effect of Crop Rotation on the Growth and Yield of Paddy.
7. Responses of Paddy to Fertilizers.
8. Sampling and Analysis of Paddy Soils.
9. Simple Fertilizer Tests on Cultivators' Fields.

* 10. Progress report on the ad hoc Working Party on Soil–Water–Plant Relationships.

* 11. Physiological Diseases of Rice.

* 12. Interaction between Varieties and Fertilizer Response.

13. Other Business.
14. Time and Place of Next Meeting.
15. Consideration of Draft Report.

**—Jointly with the Working Party on Rice Breeding.*

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